

# Smart Power Meters Offer New Way to Save Energy

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MILTON, Ontario —

The glowing amber dot on a light switch in the entryway of George Tsapoitis' house offers a clue about the future of electricity.

A few times this summer, when millions of air conditioners strain the Toronto region's power grid, that pencil-tip-sized amber dot will blink.

It will be asking Tsapoitis to turn the switch off — unless he's already programmed his house to make that move for him.

This is the beginning of a new way of thinking about electricity, and the biggest change in how we get power since wires began veining the landscape a century ago.

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For all the engineering genius behind the electric grid, that vast network ferrying energy from power plants through transmission lines isn't particularly smart when it meets our homes. We flip a switch or plug something in and generally get as much power as we're willing to pay for.

But these days the environmental consequences and unfriendly economics of energy appear unsustainable. As a result, power providers and technology companies are making the electric grid smarter.

It will stop being merely a passive supplier of juice. Instead, power companies will be able to cue us, like those amber lights in Tsapoitis' house, to make choices about when and how we consume power. And most likely, we'll have our computers and appliances carry out those decisions for us.

Done right, the smarter grid should save consumers money in the long run by reducing the need for new power plants, which we pay off in our monthly electric bills. However, if people fail to react properly to conservation signals, their bills could spike.

Certainly, a smart grid that can encourage us to conserve will feel different. Envision your kitchen appliances in silent communication with their power source: The fridge bumps its temperature up a degree on one day, and the dishwasher kicks on a bit later on another.

Smart-grid technologies have gotten small tests throughout North America, as utilities and regulators scout how to coax people to reduce their demand for power. But there's little doubt it's coming.

The utility Xcel Energy Inc. plans to soon begin a \$100 million smart grid project reaching 100,000 homes in Boulder, Colo.

In Milton, an exurb where dense subdivisions encroach on farm fields, a test with the Tsapoitis family and 200 other households reveals what will be possible — and how much more work needs to happen.

Tsapoitis uses his computer to visit an online control panel that configures his home's energy consumption. He chooses its temperature and which lights should be on or off at certain times of the day. He can set rules for different kinds of days, so the house might be warmer and darker on summer weekdays when his family is out.

The family can override those changes manually, whether it's by turning on the porch light or raising the thermostat to ward off a Canadian chill. But the system guards against waste. If midnight comes and no one has remembered to lower the thermostat and turn off the porch light, those steps just happen.

These little tweaks add up nicely for another person testing the Milton system, Marian Rakusan. He's saved at least \$300 on utility bills since the program began in September. Tsapoitis and his wife, Lisa, aren't certain of their savings but say their 2,400-square-foot home has lower energy bills than a friend's 1,800-square-footer.

This alone is not revolutionary, because programmable thermostats and other "smart home" controls let people craft similar resource-saving plans. The big change here is the combination of these controls with that blinking amber light on the switch — where the grid talks back.

Milton's local gas and electricity retailer, Direct Energy, will set those amber dots blinking in an emergency. It might happen a few times in a summer month. Maybe there will be congestion in Ontario's overtaxed transmission network. Perhaps a power plant will be down for maintenance. Or rapacious air conditioners will overwhelm electric capacity.

Whatever the cause, at that moment, this section of the grid needs a reduction in demand, fast, or else outages loom.

People in Milton's test are expected to configure a "brownout" setting on their computers, indicating how their homes should respond in such a situation. In this test, Direct Energy also will enforce conservation remotely. It can raise the set temperature in a participant's home by 2 degrees Celsius in the summer (nearly 4 degrees Fahrenheit), reducing its air conditioning load. The company also has permission to shut off the testers' hot-water heaters and electric pool pumps for four hours at time during these power emergencies.

Tsapoitis shrugs at that aspect of the arrangement. It's better than rolling blackouts. Rakusan, however, says he's not sure he likes the idea of the power company tweaking his home's settings.

Indeed, it appears unlikely that broad swaths of the public will accept remote control from the power company. California officials recently had to back away from a proposal to require remote-controlled thermostats in new buildings.

So a more likely scenario is that consumers will get powerful economic incentives to make those decisions themselves.

Typically we pay a flat rate for electricity, even if sometimes it falls below the actual costs of supplying power at a given moment. In a growing number of places, rates move slightly higher in hours that typically are busiest.

An advanced notion of this will be tested this summer in 1,100 homes served by Baltimore Gas & Electric.

Pricing plans will vary, but generally the households will pay the cheapest, "off-peak" rates most of the time. Some testers will pay higher rates every weekday afternoon. And all of them will be subject to "critical peak" periods of even higher charges, declared on as many as 12 weekday afternoons with stress on the grid.

The Maryland utility will have its own version of Milton's amber dots. Most of the homes will get 3-inch-high orbs that will glow different colors to indicate the price of electricity: red instead of their usual green, for example, during critical peak periods.

Even this will probably be a primitive step.

Eventually, the smart grid will let rates fluctuate even more dynamically, depending on conditions. That already happens in wholesale electricity markets, in which power suppliers buy energy from power producers. Now that would extend to the retail level — our homes. The price of electricity would dip when demand is softest, typically at night or on mild days, and rise in periods of strain.

There's only one problem.

"Consumers are not sitting at home waiting for the latest signal from the power grid," says Rob Pratt, a scientist with the Department of Energy's Pacific Northwest National Laboratory. "To get the kind of widespread response that we'd really like to have, keeping it automatic is real important."

In other words, appliances designed to interact with the smarter electric grid will adjust themselves.

Pratt's lab has already built and tested controllers that can make it happen. And over the next decade, Pratt expects homes to get appliance controls with a sliding scale.

At one end people could choose something like "maximize my ease and comfort." At the other, "save me the maximum amount of money."

The highest-conservation settings might lead dishwashers to start only when electricity prices are at their lowest, or when wind power has kicked on.

When Pratt and colleagues tested aspects of this in 112 homes in Washington state, they determined the average household's electricity bills would drop 10 percent.

It says a lot that conservation would be encouraged by the very companies that make money off the use of electricity. But they have no real choice.

Electricity use per home rose 23 percent from 1981 to 2001, according to the Department of Energy. Blame increases in electronics and appliances, and our decreasing tolerance for sweating through the summers. The Census Bureau says 46 percent of single-family homes completed in the U.S. in 1975 had air conditioning. In 2006 that was 89 percent.

Meanwhile, meeting that demand is getting trickier. Raw materials that fuel power plants are soaring in price and being eyed more skeptically by regulators concerned about air quality and greenhouse gases. And that's even before the next U.S. president, as seems likely, supports caps on carbon emissions.

"We just can't keep building more coal plants," says Roy Palmer, head of regulatory affairs at Xcel Energy.

So until some bountiful and clean power source can be delivered cheaply, electric utilities are pressured to extend the generating capacity we already have.

The effects of well-chosen reductions in usage — an idea known as "demand response" — can be huge. A mere 5 percent improvement in U.S. electric efficiency would prevent 90 large coal-fired power plants from having to be built over the next 20 years, according to Jon Wellinghoff, a member of the Federal Energy Regulatory Commission who advocates demand response.

Demand response isn't new, but it's existed in low-tech form. Utilities in capacity crunches would call companies and request that they do something to help, like idling an assembly line for a few hours.

In some states, residents can get rebates if they let the utility trigger radio transmitters on their air conditioners that cycle the chillers off for a few minutes in strained summer hours.

Now though, technology can do demand response in a more sophisticated way.

Companies such as EnerNOC Inc. have built software and sensor networks that can remotely dim lights or raise refrigerator temperatures inside businesses, in an instant. For homes, upgraded electric meters can offer near-real-time feedback on energy use. And new generations of appliances and thermostats can coordinate with each other and electric meters over in-home wireless networks.

The key hurdle is figuring out how to pay for it all.

The equipment in Milton's tests costs more than \$1,000 per house. That will come down with larger-scale efforts, and utilities will save money as networked meters free them from sending out human meter readers each month. But for bigger smart-grid investments, energy companies generally want regulators to let them recoup the costs through higher electric rates. That can get thorny.

Tsapotis hopes some kind of smarter system sticks after his test ends in Milton this fall. When asked why he signed up, he said it might keep his 4-year-old son, Brogan, from worrying about global warming and other environmental threats. He pointed to a tattoo running down his arm that spells out Brogan's name in an Old English font.

"That," he said, "is what we do it for."